

Improving Geo-casting by Combining Any-cast and Hovering Information

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Abstract: Geocasting is a variation on the notion of multicasting in which messages are delivered to the nodes residing in a specific area. This paper proposed a novel geocast protocol based on any-cast and hovering information in order to improve the performance by balancing load between server and local nodes. Thus proposed technique has two phases for geocasting, 1) any-cast from source to geocast region and 2) distribution of messages using hovering information. Our results have shown that using hovering information and creating replicas for geocasting messages we can reduce the overhead of broadcasting messages several times that helps in reducing the bandwidth.

Keywords: geocasting; ad-hoc network; information hovering; geocast protocols; network clustering.

1. Introduction:

Current protocols [1-4] developed in the area of ad-hoc network for geocasting use the combination of any-cast and broadcasting. Different techniques for broadcasting involving blind flooding, selective flooding have been proposed to date [3]. The drawback of these techniques is that messages are transmitted from the source nodes each time. This drawback not only leads to extra consumption of bandwidth but also sending messages to newly entered nodes needs calculation of full path each time. This problem has not been addressed each time. This is

because of the limitation that in all geocasting protocols, that have been presented to-date nodes in the geocasting region can only flood message once.

The concept of hovering information was presented in [1] to enables sharing of information in a specific geographical area that is kept alive or stored for only that particular topographical content [1][2]. A piece of hovering information is generated by some application running on a specific node and is valid for a specific geographical area called hovering area. Each node within hovering area stores and broadcasts the hovering information periodically within its own domain where nodes in hovering area may be connected to each other through ad-hoc connectivity. Part of hovering information is omitted when nodes leave out of hovering area.

In this work we have applied hovering information with any-cast in order to address limitation of current work in the domain of geocasting. In our propose technique the message is not only flooded within the geocasting area but also keep alive in the geocasting area and enable distribution of messages using nodes reside within geocasting region instead of obtaining from external source each time. Once the message arrives in the geocast region it tries to store it and keep replicas on as many possible nodes. In this way a new node that enters the geocast region can obtain the geocast messages locally. By using this technique of combining any-cast with hovering information we have observed good performance achievement in terms of bandwidth usage and information accessibility.

Our second contribution of this work we have used clustering based environments for information distribution within the geocasting region. Clusters are created using autonomous clustering algorithm where each newly coming nodes join the cluster. We further have performance experiments for sparse and dense mode and have consider the cluster behavior as well information delivery in both cases.

The rest of the paper is organized as follows; Section 3 explains the hovering information concept followed creation and management of clustering in ad-hoc network in section 4. In section 5 we have explains our proposed technique by combing hovering information and any-cast and have discuss different scenarios. Section 6 presents the experiments and results followed by section 7 that concludes the paper.

2. Hovering Information:

The hovering information [6] can be viewed as an overlay on top of P2P networks and ad-hoc network and autonomous networks and it links different pieces of information based on physical / geographical locations. Instead of any server hovering information is stored on the local nodes moving or staying within anchor area. These nodes delete them information as leave the linked area.

A piece of Hovering Information can be viewed as images, text, videos, audio format. It can be a message or a document. A hovering information piece is linked with its anchor point also

called hovering area. An anchor point consists of a GPS point and anchor radius from that GPS point. An anchor area can be of any volume. However usually it is kept circular for the convenience. In this work we have used circular and rectangular radius area. The circular area is recognized using anchor point that is in the center and its radius and rectangular area is recognized using a GPS point in the center height and width of the rectangle. This work only covers 2D anchor areas and it does not address 3D anchor areas. The properties of hovering information messages are survivability, availability and accessibility and are defined as follows;

A piece of hovering information stored on any node is called a replica of that hovering information message. The replicas of hovering information are equal to the number of nodes hosting that specific hovering information.

A piece of hovering information is considered as service if there exists a single node hosting the replicas of the hovering information. The survivability represents the ratio of time in which hovering information was remained alive with overall observation time.

A piece of hovering information is considered as available if there exists a single node within anchor area hosting piece of hovering information. The availability represents the number of nodes hosting the piece of hovering information with total number of nodes within hovering area.

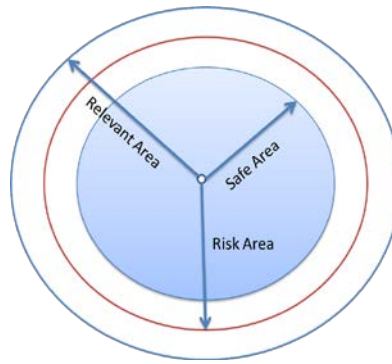


Figure 1. Safe risk and relevant areas.

For a node, a piece of hovering information is accessible if it can create a replica of it. The accessibility of some hovering information message represents ratio between number of nodes that can access the information and total number of nodes within hovering area.

Each piece of hovering information strives for making itself available in all parts of anchor area. To achieve this objective it tries to create maximum replicas of itself on different nodes moving and straying to different parts of anchor area. Our study shows that number of availability has very close relationship with number of replicas. We also examined that in more dense area more replicas are needed where in sparse area few replicas also work fine.

The anchor area for each piece of Information is divided into three different sub-areas as shown in figure 1, 1) Safe area, 2) Risk Area and 3) irrelevant area. Hovering information

staying in the safe area can stay in any node and can create replicas on any available node. Hovering Information stored on the nodes in the risk area try to create its replicas on the nodes moving towards safe area and Hovering information stored on the nodes entering in the irrelevant area remove them self from the nodes.

3. Clustering:

Cluster is subset of nodes containing three or more than three nodes called cluster-members lead by a node called cluster-head [4]. In this paper we have used clustering mechanism for distribution of Hovering Information among the nodes in the anchor area. Following is the method we have used for formation of cluster

When a new node makes itself active it first starts searching for the clusters around it by broadcasting HELLO message packet. In the first where it doesn't receive any response after a certain amount of time passed it creates new clusters and becomes the cluster-head.

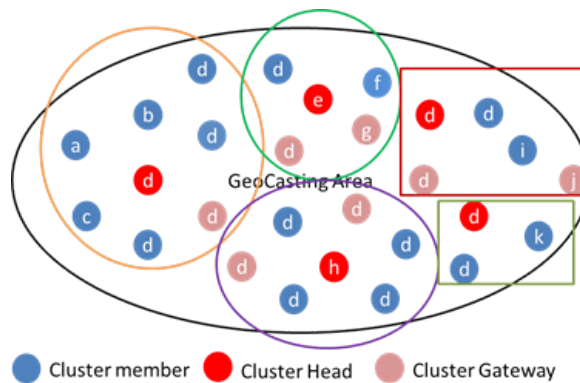


Figure 2. Example of an autonomous clustering scheme.

In the second where there exists already one or more than clusters it receives response from the nodes containing cluster ID that is similar to the ID of cluster-head, geographical location of the responder, physical distance from cluster-head and number of hops between responder and cluster-head. A node can receive more than one message in response of HELLO message. In case it receives only a single response it is easy for it to join the only available cluster. However if it receives more than one response it first finds the distinct message with respect to clusters and then checks again if all messages are from the same cluster members, in that case it also joins the only available cluster. The other case is where it receives responses from members of more than one cluster and it has to choose the closest one in order to achieve better performance in terms of information gathering and delivery. The choice is made based on the three parameters, moving direction, number of hops and physical distance between node itself and the cluster-head of the cluster it wants to join.

Let D is the direction represented by 1 or -1 for same and opposite direction respectively, h is number of hops between node and cluster head and K is the physical distance between node and cluster head. If $R(D, h, K)$ is the set of responses; it is first sort by direction by descending that brings all cluster-heads moving towards the same direction of the node on top. Secondly from those top records it sort based on number of hops between node and cluster-head that brings the cluster with minimum number of hops on top and finally nodes with the minimum hops are sort using physical distance that brings the most nearest cluster on top. Eventually the cluster of first element is joined by the node.

A cluster head is the member of the cluster with maximum number of neighboring nodes. This condition should always satisfy for the cluster head. A cluster-head of a cluster is changed because of two different conditions, first is if some other node has more neighboring nodes from the cluster-head and second is cluster head accede from number of cluster-members and wants to break cluster in two different clusters.

The cluster-head periodically broadcast the number of its first neighbors across the cluster that is received by all cluster. After receiving the message each time, each node compare its number of neighboring nodes with the neighboring nodes of cluster-head and if they are more than number of cluster-head it request the cluster-head to delegate him the responsibility of cluster-head. When a cluster head accede the number of connection (connection limit it broadcast a new cluster creation packet to its cluster member. Each node that receives cluster creation packet, respond back to cluster-head with its geographical location and number of neighbouring nodes. The cluster-head after receiving the responses decide the new cluster-head on basis of maximum number of neighbouring nodes.

4. Proposed Technique for geocasting using Hovering Information:

In this section we explain our proposed technique for geocasting based on hovering information. We mainly utilize the any-cast for delivering packet from server to any node in the geocasting area. In following we first explain relationship between geocasting messages and hovering information pieces. There are many common properties between geocasting and hovering information. The most important common property is anchor area that can also be said as geocasting area. A piece of hovering information is supposed to stay in the region where a geocast message is supposed to be delivered on each node available in the geocast region at time of delivery. The main advantage of hovering information over the traditional geocasting is that hovering information allow replicas of the messages and when new nodes enters in geocasting area or anchor area they can get messages locally instead of invoking request from server. In this section instead of using anchor area we have used the term geocast region and each geocast message is considered as hovering information piece.

Our proposed algorithm works as follows; Consider a message M is send for a s pecific geocasting region R from the server. It first finds the way to reach in R and deliver the message to any node available in the area R . Let suppose this message is delivered to N – a nod in the geocast region – and also member of some cluster. Once N receives the message it instead of flooding the message at the first step stores the message and forwards it to the cluster-head. A geocasting area can consist of one or more than one autonomous clusters. These clusters can fully cover the geo-casting region or partially cover the geo-casting area. When a cluster-head receives a packet it first check in its local database either it has received the message already or not. Any message that a cluster head receives can be of three types, first a totally new message, secondly an update for any existing message and third a duplicate message. If it is duplicate message and cluster-head has already forward the copy of message to its cluster-members it simply discard the message. If the message is new message and has not been forwarded already or if it is an updated copy of already sent message it is forwarded to cluster-members. Each member receives the message stores a copy in its local-database. However when a gateway node receives the message it not only stores the message but also forward to its connected gateways nodes of other cluster. In this way messages are transferred from one cluster to another cluster. Eventually all nodes in the geocast area receives the message.

In above we have explain the simple situation when a new message arrive in a dense area we now consider the sparse mode where nodes in the geocast region are not connected with each other, figure 2 shows a scenario where nods in geocast area are not connected with each other. Here we define our mechanism for dealing this kind of scenarios where nodes need help from external nodes – outside geocasting region – to deliver geocast messages.

As we explain the section 3 that a hovering information location of hovering information is represented by three radiuses safe, risk and relevant. Here we first map this area for geocast region.

For sparse mode we have set radius for risk area similar to radius of geocast region to ensure that maximum number of external nodes can be involved in the delivery mechanism to ensure the delivery to the maximum number of nodes in the geocast region. Each node moving outside from risk area passes the information to the nodes moving towards the safe area. We have used the GPS location to obtain the direction of mobile nodes.

To deliverer the messages to nodes that enters in the geocast region after the message has been geocasted. The first one is pull based technique in which data is pulled from the cluster-head and other one is push based technique. In pull based technique when a new nod enters in the geocast region and joins a cluster instead of waiting for next geocast from the server it ultimately asks the cluster-head for the list of geocast messages available for the region. The cluster-head then provides the messages for geocast region. After receiving the message-list it ask the cluster-head to deliver the messages that are available tern by turn. In push based technique cluster-head periodically used to broadcast the list of available geocast messages to the

nodes and any node that misses any message can request from cluster-head for delivery of those messages.

Finally we present when a node should delete the message as mobile nodes have limited memory so they cannot store the unlimited messages. Once the node leaves from risk area it deletes the stored geocasting messages from its memory. For this a thread keeps monitoring of all geocast messages in the geocast database.

5. Results

To measure the performance we have implemented our protocol on NS2 network simulator version 2.34. NS2 was run on Ubuntu operating System on the machine having 2GB of RAM and 2.24 GHz dual core processor. We compare our algorithm with position based grasping, blind flooding and selective flooding. For this work we have limited the scope and evaluated only two evolution parameter that are efficiently in term of time and usage of bandwidth. We make separate experiments for sparse and dense mode. The random walk algorithm was used to generate the motion of mobile nodes. Hovering Information Application and Geocasting protocol was installed on each of the node.

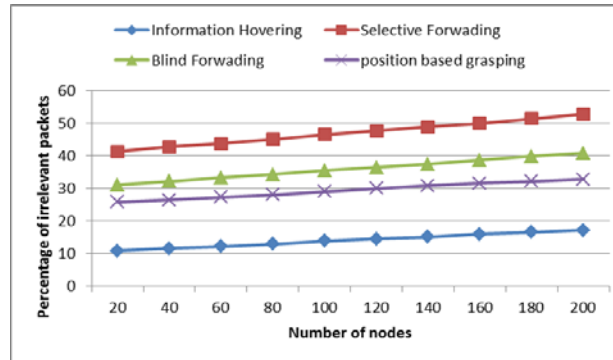


Figure 3. Time needed to get geocasted method for new node.

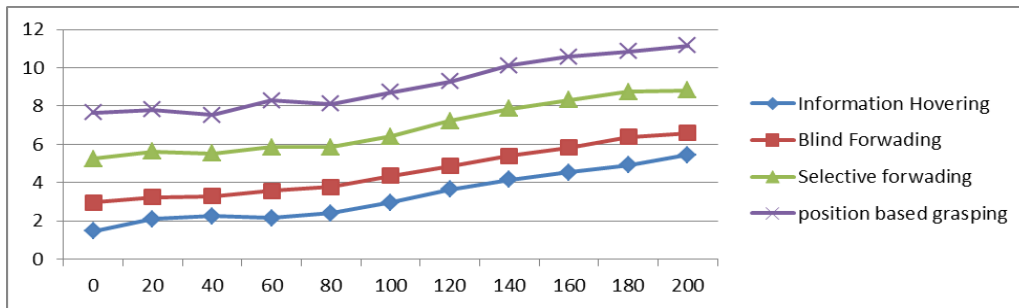


Figure 4. Message overall delivery time.

Figure 3 shows the time required by a new node to get the geocast messages available for the region. In all other three cases the geocasting message is transmitted from the original source. However in Information hovering based geocasting it is only transmitted by from the server if the geocast messages are not accessible. Results show the clear improvement in the results using the proposed approach with compare to existing approach. This is because of the rational that the accessible time reduces when information is accessible from the Geo-Cast region instead of geocast sources. The less mobility node will be having the more stable clusters. If we imagine the disaster area this technique works very good as the moving speed of nodes in disaster area remain very slow as the movement of volunteers working in some area don't move very quickly. In addition, this technique also woks good with the high mobility rate as well. Although the nodes leave and join the cluster very quickly in the high mobility mode however we has found that cluster creation remain stable in high mobility mode also. Our cluster algorithm works find for node not accessing the limit of 120 km/h.

Figure 4 shows the average number of time needed to deliver a message in a dense area using different techniques. The performance of hovering information is better than all other cases because of its quick information replica creating system. This experiment was made on different number of nodes as figure 4 depicts. As the number start increasing the time is getting more and more. The reason for PbG is taking more time is because of its path calculation and same is for the selective forwarding however we can see that blind forwarding and hovering information works good where hovering information also work better than the blind forwarding as well.

6. Conclusions

In this work hovering information based novel technique has been proposed for accelerate the process of geocasting in ad-hoc networks. The proposed technique comprises of hovering information and clustering. The clustering has been used for data dissemination within the geocasting area. The results demonstrate that applying hovering information instead of simple flooding or broadcasting provides better results and improves the performance in term of maximizing the output in minimum time using minimum network resources.

Acknowledgement:

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2011-0012329).

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